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**Space Weather Technical Forecast**

Issued on Wednesday, 22 November 2023 at 01:25 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>**

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**Space Weather Forecast Headline: Chance of R1 Radio Blackouts throughout. Chance of G1 Geomagnetic Storms, day 1 and day 4 (22 Nov and 25 Nov).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Low activity has been observed with only C-class flares, the largest a C7.7 at 21/1352UTC from AR3492. There are currently ten sunspot groups on the disc, the majority of which are located in the eastern solar hemisphere. AR3492 is the largest at present, located in the northeast and surrounded by several simple peripheral spots, each numbered individually. This spot has grown recently, increasing in length. AR3489 in the southeast maintains its magnetic complexity, with a delta spot present, now within its trailing portion. The only other notable spot is the recently emerged and yet unnumbered region in the southwest, this spot is showing signs of growth. All other spots are simple and stable at present. No Earth-directed CMEs observed in the past 24 hours.

**Solar Wind / Geomagnetic Activity:** Solar wind parameters, as measured by ACE and DSCOVR at L1, have been indicative of a connection to a coronal hole high speed stream, likely that of CH73/+. Wind speeds have risen erratically from 300 km/s to 470 km/s. The solar density, has been on a similar erratic but rising trend, becoming above average from 21/1120 UTC onward, peaking at 20 ppcc at 21/2156 UTC. The IMF was predominantly moderate, peaking at 15nT at 21/2218 UTC. The important north-south component (Bz) had three periods of consistently moderately negative between 21/0600-0730, 21/1200-1345 and 21/1845-2200 UTC, falling to -14nT at 21/2115 UTC. Finally, the phi angle was mainly positive (away from the Sun). The net result of the above solar wind parameters was largely Unsettled to Active geomagnetic activity.

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux remained at Background levels.

GOES16 high energy (greater than 2MeV) electron flux remained at background levels. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu). The fluence observation at 22/0000UTC was 1.84e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** There is a daily Chance of M-class flares, mainly from current eastern solar hemisphere sunspot regions.

**Solar Wind / Geomagnetic Activity:** No Earth-directed CMEs feature in the forecast. Earth is currently connected to the high speed stream of coronal hole CH73/+. Wind speeds could reach up to 500 km/s before easing later on day 1 (22 Nov) back to slightly elevated or background. No further enhancements expected until the arrival of CH75/+ later on day 4 (25 Nov).

Unsettled to Active with a Chance of G1/Minor Storms expected through the first half of Day 1 (22 Nov), before becoming largely Quiet to Unsettled later in the day. Quiet Geomagnetic activity is then expected to dominate through days 2-4 (23-25 Nov) before the arrival of CH75/+ later on

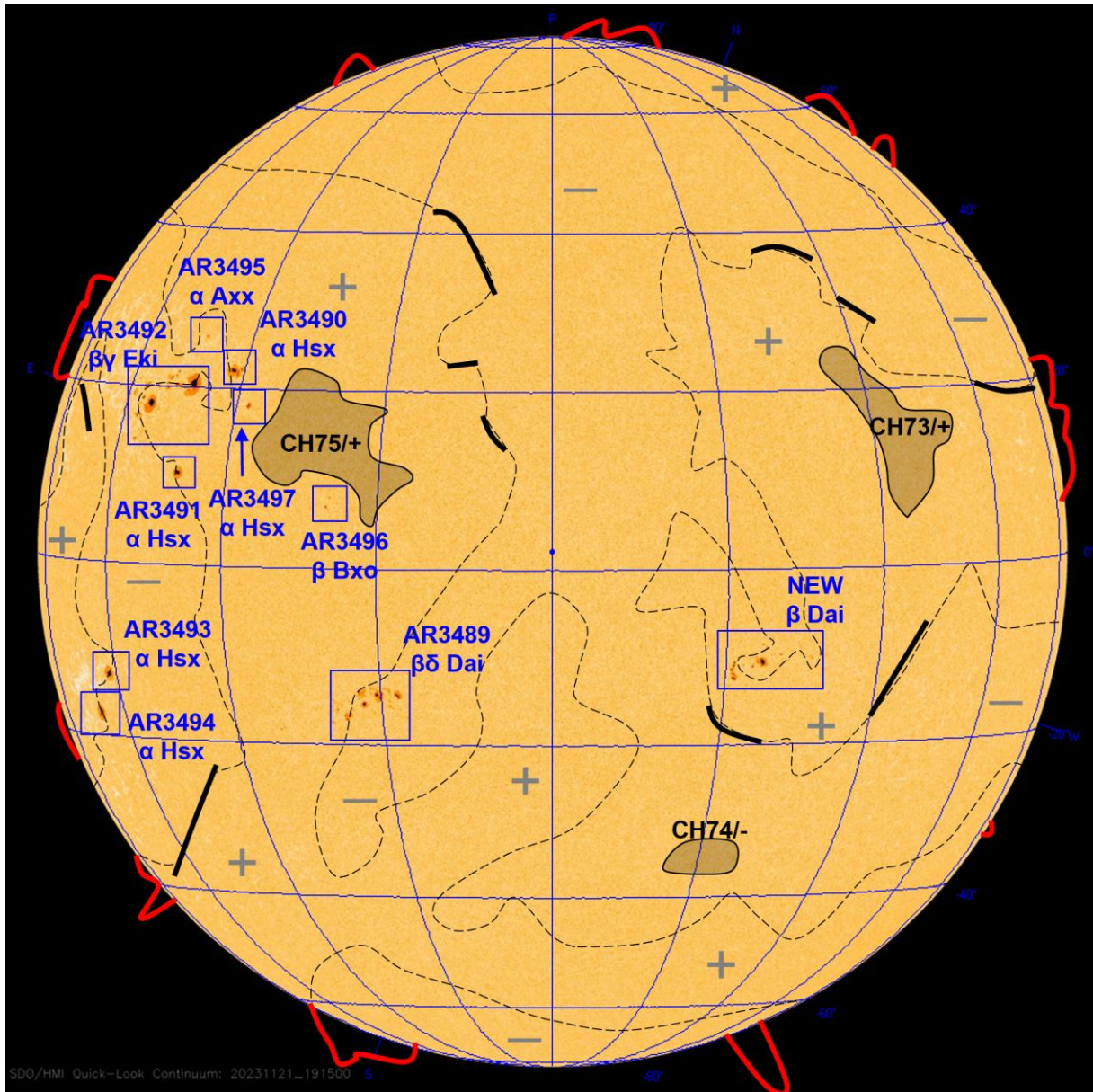
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day 4 (25 Nov), bringing a chance of G1/Minor Storm intervals to end the period.

**Energetic Particles / Solar Radiation:** GOES16 high energy proton flux is expected to remain at Background levels.

GOES16 high energy electron flux is expected to be background to moderate initially, before perhaps rising from day 2 (23 Nov). The associated 24-hour electron fluence will most likely remain below the Active (1e8 integrated pfu) level in this four-day period, but with a risk of breaching the Active threshold days 3 and 4 (24/25 Nov).

**Figure 1. Solar Analysis Valid 21/1915 UTC.**



**Key:** Filament \_\_\_\_, Prominence \_\_\_\_, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

## Geomagnetic Storms:

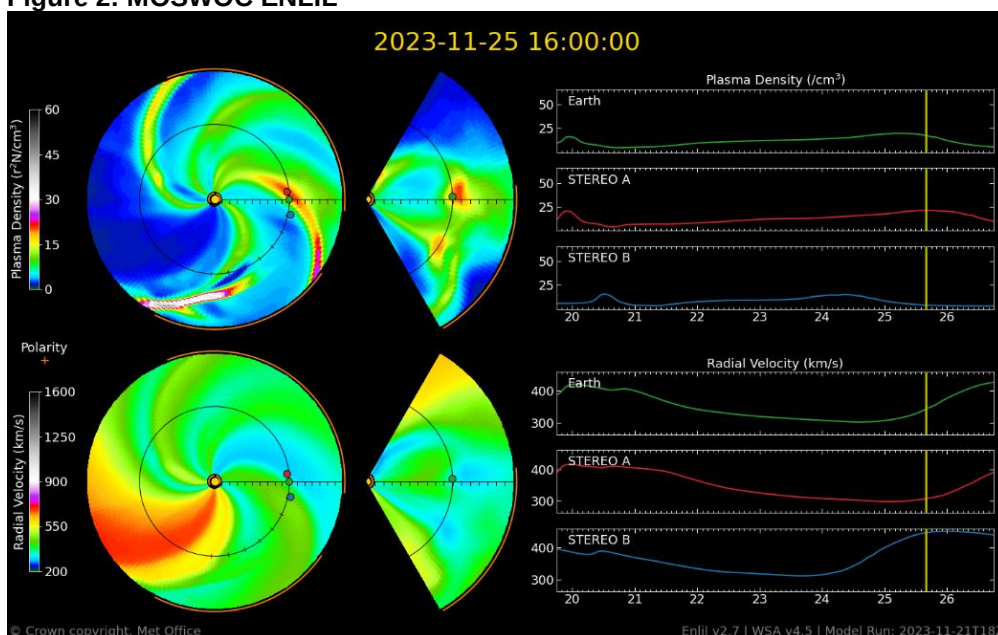
No Earth-directed CMEs currently feature in the forecast.

Earth is currently thought to be connected to the high speed stream of coronal hole CH73/+, with an increasing wind speed. Wind speeds could reach up to 500 km/s during the first part of day 1 (22 Nov) before easing later in the day back to slightly elevated or background. No further enhancements are then expected until the arrival of CH75/+ later on day 4 (25 Nov) or perhaps beyond the forecast period. On the previous rotation, this coronal hole was a much larger and darker feature that it appears currently, with speeds reaching 570 km/s and a prolonged period at elevated. Geomagnetic activity on the previous rotation was Kp 3-5. Therefore it is thought that similar if not a slightly muted version of events will take place upon the connection of the CH73/+ on this rotation. Speeds of up to 500-550 km/s are possible briefly.

Unsettled to Active with a Chance of a G1/Minor Storm is expected through the first half of Day 1 (22 Nov), before becoming largely Quiet to Unsettled later in the day. Quiet Geomagnetic activity is then expected to dominate through days 2-4 (23-25 Nov) before the arrival of CH75/+ later on day 4 (25 Nov), bringing a chance of G1/Minor Storm intervals to end the period.

| Geo-Magnetic Storm       | Level    | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|--------------------------|----------|------------------------|-------------------|-------------------|-------------------|-------------------|
| Probability (Exceedance) |          |                        | (%)               | (%)               | (%)               | (%)               |
| Minor or Moderate        | G1 to G2 | No                     | 40                | 5                 | 1                 | 30                |
| Strong                   | G3       | No                     | 1                 | 1                 | 1                 | 1                 |
| Severe                   | G4       | No                     | 1                 | 1                 | 1                 | 1                 |
| Extreme                  | G5       | No                     | 1                 | 1                 | 1                 | 1                 |

Figure 2: MOSWOC ENLIL





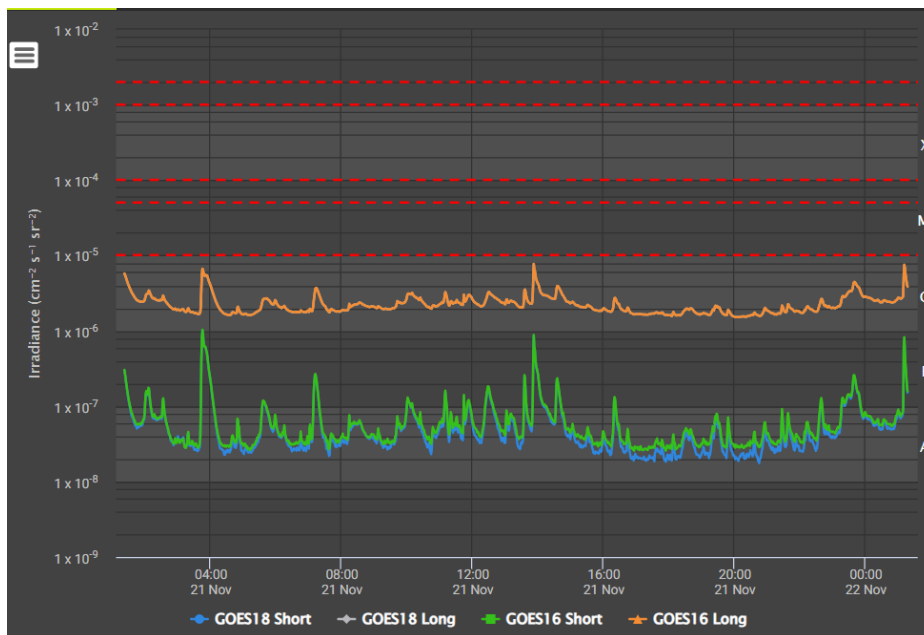
## Radio Blackouts - X-Ray Flares:

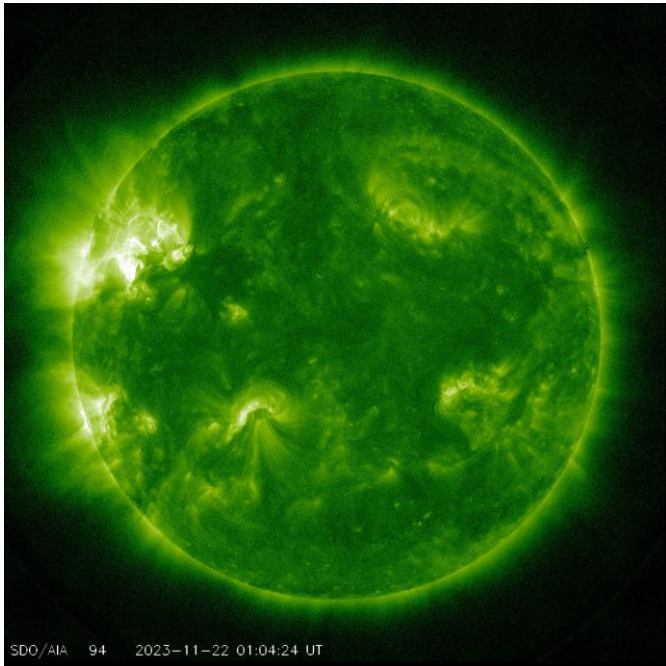
There are currently ten sunspot groups on the disc, with the majority of which are located in the eastern solar hemisphere. AR3492 is the largest at present, located in the northeastern hemisphere and surrounded by several simple peripheral spots with their own numbers. This spot has grown recently, increasing in length. AR3489 in the southeast maintains its magnetic complexity, with a delta spot present, now within its trailing portion. The only other notable spot is the recently emerged and yet unnumbered region in the southwest, this spot is showing signs of growth. All other spots are simple and stable at present.

All considered, there is a continued Chance of M-class flares given the complex eastern solar hemisphere. There is the potential for more regions arriving around the eastern limb, though there is little evidence to suggest any region currently has increased activity. X-class flares are now also considered a daily Slight Chance given the potential for development.

| X Ray Flares | Level               | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|--------------|---------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability  |                     |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active       | R1-R2<br>M Class    | No                        | 40                   | 40                   | 40                   | 40                   |
| Very Active  | R3 to R5<br>X Class | No                        | 5                    | 5                    | 5                    | 5                    |

Figure 3: 24 hour X-ray trace & current SDO 94 Imagery





## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background levels.

Two large and complex regions on the eastern solar hemisphere has resulted in an above background risk of a S1/Minor Solar Radiation Storm. This risk remains nominal until any significant groups approach the western solar hemisphere.

| Radiation Storms                                                                                                                                             | Level<br>( $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$ ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance)                                                                                                                                  |                                                            |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active                                                                                                                                                       | $\geq \text{S1}$                                           | No                        | 5                    | 5                    | 5                    | 5                    |
| Very Active                                                                                                                                                  | $\geq \text{S3}$<br>*                                      | No                        | 1                    | 1                    | 1                    | 1                    |
| * S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$ . (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$ ) |                                                            |                           |                      |                      |                      |                      |

## High Energy Electrons Event ( $\geq 2\text{MeV}$ ):

Electron flux levels are expected to continue fluctuating between Normal Background and Moderate flux levels initially, being suppressed by the current coronal hole high speed stream. Later in the period flux levels may increase with a chance of the High 1000 pfu threshold being breached near the diurnal maximum, as coronal hole high speed stream influences wane. A further suppression is possible toward the very end of the forecast period, or perhaps slightly after, due to the arrival of the HSS of CH75/+

Fluence levels are expected to remain below the  $1\text{e}8$  Active threshold initially, the risk of this being breached increases during day 3 and 4 (Nov 24/25) as CH HSS effects wane and the electron belts recover after a period of charging.

| GEO Electron Environment | Level ( $\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$ ) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|--------------------------|-----------------------------------------------------------|------------------------|-------------------|-------------------|-------------------|-------------------|
| Probability (Exceedance) |                                                           |                        | (%)               | (%)               | (%)               | (%)               |
| Active                   | $\geq 2 \text{ MeV}$<br>$\geq 1 \times 10^8$              | No                     | 1                 | 10                | 30                | 40                |
| Very Active              | $\geq 2 \text{ MeV}$<br>$\geq 1 \times 10^9$              | No                     | 1                 | 1                 | 1                 | 1                 |

Figure 4: MOSWOC REFM integrated flux obs/forecast/persistence

